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ROYAL AIR FORCE (part one)

The 1917 Bristol fighter, which made a decisive contribution to British air supremacy towards the end of the First World War

IT was a hard fight to make a beginning, hard to survive the first 50 years, and it looks like getting tougher still for the Royal Air Force to hold its own as the youngest and most adventurously independent of Britain's three fighting services.

In the beginning the struggle was to prove that flying was practical, and then to show that aircraft were the most potent war machines ever devised. The middle years, between the First and Second World Wars, were the time of endless campaigning to win fair shares of money, men, and equipment against the entrenched Royal Navy and the Army, and to prepare for a war which only the airmen fully realised would be won or lost in the air.

Today the RAF still stands almost alone in its conviction that future strategy must move out into space, whatever the cost, and that new aircraft developments, like vertical take-off, are truly adding a third dimension to sea and land warfare. Again, only airmen understand this and have the skill and experience to command and operate the new craft.

The origins of the RAF

The RAF traces its birth to Woolwich Arsenal in 1878, where the first military experiments with balloons in Britain were made by men of the Royal Engineers. Two years later these men had five operational balloons, and opened a depot at Farnborough, Hampshire, which is today the site of the Royal Aircraft Establishment. During the Boer War of 1899 to 1902 the Royal Engineers formed a special balloon section, which used balloons for scouting and directing artillery fire.

By the beginning of the 20th century petrol engines were being improved, and airships and aeroplanes were taking the place of balloons. The Army built and flew its first airship, *Nulli Secundus*, in 1907, and the first officers learned to fly fixed-wing aircraft in 1909. They had to pay for their own lessons; it was not until three years later, on 13th May 1912, against strong opposition, that the Royal Flying Corps was formed.

The Royal Flying Corps

This new Corps had two wings, or sections – a military wing for men and aircraft that were attached to the Army, and a naval wing for those attached to the Navy. The Army used the Central Flying School, Netheravon, for training its officers, but the naval branch trained its personnel independently. The name of this latter branch – the Royal Flying Corps, Naval Wing – was later replaced by the name Royal Naval Air Service, or RNAS.

At this time France was ahead of most other countries in the building and flying of aircraft, and almost all the early aeroplanes of the Royal Flying Corps were French. But some great British pioneers, like A. V. Roe and T. O. M. Sopwith, designed their own machines, using French engines, and in 1914 the Royal Aircraft Factory at Farnborough built a new 90-horsepower engine and fitted it in an aeroplane of its own design called the BE2 C.

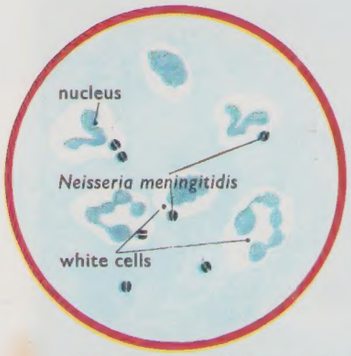
Previous page: top left, the 1935 Bristol Bulldog – a famous fighter between the wars; top right, the 1933 Fairey-Napier monoplane – used in the long-distance flights; centre, the RAF flag; below, Hawker Harts flying over the Himalayas (1933) – a symbol of the new role of the RAF as guardian of the peace throughout the British Empire.

MENINGITIS

THREE membranes surround the human brain. They are called the *meninges* (pronounced men-nin-gees), and their function is to support and protect the delicate brain tissue. The outermost of these three membranes is called the *dura mater*. It is tough and fibrous, and is firmly attached everywhere to the inside of the skull. Beneath the *dura mater* lies the thinner *arachnoid mater*, and beneath this is the innermost and finest of the membranes, the *pia mater*. Between the *arachnoid mater* and the *pia mater* there is a small space, which is filled with a colourless fluid known as the *cerebrospinal fluid*. Its function is to cushion the brain against the skull when the head is sharply moved. At the rear end of the brain all three meninges are continued down the spinal canal as wrappings for the spinal cord.

Lying as they do within the skull and the spinal canal, the meninges have no contact with the outside world, and so they are normally quite *sterile*, or free from microbes. Occasionally, however, germs of various kinds find their way to the meninges and lodge and multiply there. In response to microbial invasions of this kind the meninges become inflamed, and this condition is known as *meningitis*.

Before the discovery of the sulphonamide group of drugs in the 1930s (see page 612) the treatment of meningitis was very unsatisfactory, and many of its victims died. Today, however, several drugs are available for the treatment of some kinds of meningitis, and the outlook is much improved.



White cells containing pairs of Neisseria meningitidis

Cerebrospinal fever

The most alarming form of meningitis is the type known as *cerebrospinal fever* or *spotted fever*, since it occurs in epidemics. Fortunately, in Britain today it is a rather unusual illness.

The microbe which causes cerebrospinal fever was discovered in 1877 by an Austrian pathologist, Anton Weichselbaum, and for many years it was called *Weichselbaum's coccus*. Today, however, it is usually known as *Neisseria meningitidis*. This bacterium is bean-shaped and about 1/10,000th of an inch long. The microbes very frequently occur in pairs, with their concave sides adjacent.

An interesting feature of *Neisseria meningitidis* is that it is readily ingested (absorbed) by the white cells of the blood which congregate at the inflamed meninges. In consequence a little of the cerebrospinal fluid removed from a cerebrospinal fever victim usually contains many white cells with microbes inside. Doctors often make use of this feature of the disease when making a diagnosis.

Cerebrospinal fever is not a particularly infectious disease, and in temperate countries, at least, epidemics are seldom large. The microbe lives in the nasal passages as well as in the meninges, and from here it is spread during talking and coughing.

Carriers, or people who harbour the microbe in their noses but who are otherwise unaffected by it, often help to spread the illness.

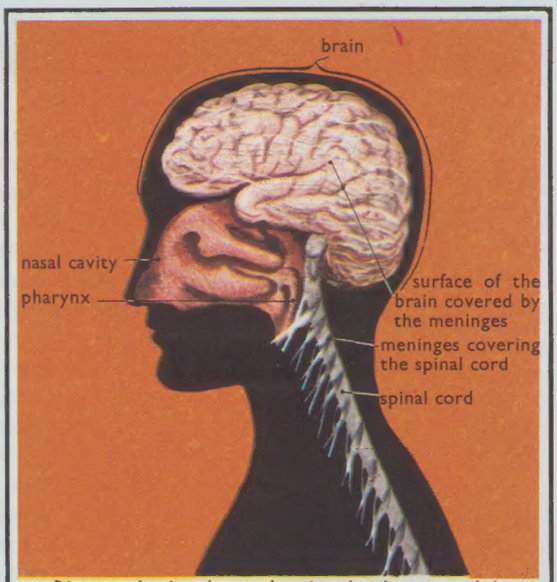


Diagram showing the nasal cavity, the pharynx, and the meninges which cover the central nervous system – the parts of the body affected in cerebrospinal fever

An attack of spotted fever begins, after an incubation period of four to five days, with a headache, stiffness in the muscles of the neck, and an intense dislike of light. Strangely enough, the rash which has led to the name *spotted fever* is not a constant feature, and quite often does not appear.

The treatment of cerebrospinal fever is aimed at killing the invading microbes. The sulphonamides and some of the newer antibiotics are used with great success for this purpose.

Of mice and men

Another variety of meningitis – far less serious than cerebrospinal fever – is that which is known as *aseptic meningitis*. This illness is caused by infection of the meninges with certain viruses, and though it is very unpleasant, it is seldom fatal.

The most important of the several different viruses which cause aseptic meningitis are the *Coxackie* viruses, a group of microbes whose strange name is derived from the American town in which they were first discovered. About one-tenth of the cases of virus meningitis, however, are due to infection with a quite different virus. It is one which usually exists in mice, and though in the mouse it seems to be quite harmless, in man it causes an illness called *lymphocytic choriomeningitis*. Fortunately – for there are no drugs which affect the course of this infection – victims of this illness usually recover spontaneously.

Other kinds of meningitis

Whenever microbes invade the body it is always possible that some will find their way into the bloodstream. They may then be carried to the meninges and there cause meningitis. For example, in the days when tuberculosis of the lungs was a common infection it was not unusual for the later stages of the disease to be complicated by tuberculous infection of the meninges. Fortunately there are very many fewer cases of tuberculosis of the lungs today, and consequently many fewer cases of tuberculous meningitis. Furthermore, when the disease does occur there are several drugs which can be used successfully in its treatment.

Another infectious illness which may lead to meningitis is pneumonia. Many different organisms cause this illness, but that which spreads most commonly to the meninges is the microbe responsible for *lobar* pneumonia, *Streptococcus pneumoniae*.

Finally the meninges may be infected directly. This sometimes happens to young children who have infected and running ears. It can also happen in very serious fractures of the skull when the meninges may be contaminated by microbes from the atmosphere, from dirt, or from the victim's skin.

THE GRAMPIANS

Ben Nevis, the highest mountain in Britain, lies humped like a great whale over Loch Linnhe and Fort William

'By Tummel, and Loch Rannoch and Lochaber I will go,
By heather tracks wi' heaven in their wiles;'

THIS, according to the well-known Scottish folk song, is the Road to the Isles; and it runs through the Grampians, the great mountains in the heart of Scotland.

The name Grampians can refer to one comparatively small group of mountains, but it is also used to describe that part of the Scottish Highlands lying between the Highland Line (or, in geographical terms, the Highland Boundary Fault) in the south and Glen More, or the Great Glen, in the north. In this article we are going to look at the wider area.

The Grampians run from south-west to north-east, and are built up of very old, hard, crystalline rocks, moulded by Ice Ages, and dissected by rifts and rivers. They include Ben Nevis (4,406 feet), the highest mountain in the British Isles, and the mountains of the Cairngorms group. Much of the Grampians lies between 3,000 and 4,000 feet above sea-level, and rivers flow from them westwards to the Atlantic Ocean, and eastwards to the North Sea.

The climate is definitely not the best feature of the Grampians. In July the average temperature may be only about 50°F, and the west is very wet. The east is much drier – the annual rainfall is about 20 inches less at the east end of Loch Tay than it is at the other end, 15 miles farther west. In winter the region is snow-covered – but this has been turned to advantage, for ski-ing has been encouraged and, particularly in the Cairngorms, is now a flourishing sport.

In the west

In the west the Grampians run close to Glasgow. About their closest point to it is the Trossachs – the 'bristled country' – a district which extends roughly from Aberfoyle to Callendar. The Trossachs rises sharply from the farmlands, and was made popular by Sir Walter Scott's *Lady of the Lake* and *Rob Roy*. Wordsworth, his sister Dorothy, and Coleridge, toured this part of Scotland and were deeply impressed by its beautiful scenery, although Dorothy compared nearby Loch Lomond unfavourably with her beloved Lake District.

Only about two hours' drive north of Glasgow stands Buachaille, a mountain which is one of the most popular climbing centres in Scotland. It stands between Glen Etive and Glencoe. The latter is notorious for the bloody massacre which took place there in 1693, when 120 men of Argyll's regiment, who had been billeted and hospitably entertained in the glen, rose up and massacred its inhabitants.

North of Glencoe lies the region of Lochaber. It reaches north to Glen More, and part of it is covered by the Mamore Forest. This is not a forest of trees in the usual English sense; in the Highlands the word usually means uncultivated land used for sport. Most of the Mamore Forest consists of a range of mountains, sandwiched between the Leven and Glen Nevis. They are capped with quartzite, so even in summer they look as though they are covered by snow.

Fort William is a great tourist centre at the foot of Ben Nevis; in its West Highland museum are many relics of Prince Charles Edward, who wandered in Lochaber after the battle of Culloden. Hundreds of people visit Fort William each year, and from it climb Ben Nevis. This mountain, snow-capped for much of the year, lies right in the track of North Atlantic hurricanes, and the summit has an average of 261 gales a year. It is easy to reach the summit from lower Glen Nevis, but on the north-east are great cliffs, dropping 2,000 feet.

Geographical position of the Grampians

Moors and rivers

East of Glencoe lies Rannoch Moor, which stretches over 56 square miles. Much of it lies between 950 and 1,000 feet above sea level. This is wonderful country for walking, with many little tarns but quite dry peat soil between them. From Rannoch Moor the rivers Etive and Orchy drain to the Atlantic, while the river Ba runs through Loch Rannoch to Loch Tummel, and eventually to the Tay, forming a line of slow-flowing rivers and lochs right across the moor. Only a few hundred years ago Rannoch Moor was a vast forest of pines, stretching from the Braes of Mar and Strathspey to Glencoe and Glen Lyon. The remains of this old forest can still be seen at Loch Tulla and Crannach, and in the 'Black Wood of Rannoch'. At the time of the battle of Bannockburn (1314) reindeer lived in these woods, which in the 16th century were absolutely infested with wolves. Today the waters of Rannoch Moor are being harnessed to provide hydroelectricity.

Several great Scottish rivers start in the Grampians and flow eastwards. Two of the most famous are the Dee and the Spey. The Dee flows north-east past Braemar, famous for its Highland Games, Balmoral, the Scottish home of the Queen, and Aboyne, which also has Highland Games. If you drive north to Braemar from Perth you cross the famous zigzag pass known as the Devil's Elbow. This district was greatly loved by Queen Victoria, who built the castle of Balmoral and bought land stretching south to the granite summit of Lochnagar. Ever since the 1850s the Royal Family has kept up the custom of a summer holiday on Deeside. Overlooking Balmoral from the top of a small hill is a cairn erected by Queen Victoria in memory of her husband, Prince Albert.

The river Spey, north of the Dee, is the fastest-flowing river in Scotland. It runs between the Monadhliath Mountains and the Cairngorms, and its valley, Strathspey, has given its name to a Highland dance step. Extensive flood meadows show the havoc which used to be wrought by the river, but this hazard has now been lessened by the diversion of its headwaters for hydroelectricity.

The Cairngorm mountains are the highest mountain group in Britain, with six peaks over 4,000 feet high. The smoky yellow, semi-precious stone called the cairngorm, or Scottish topaz, is named after these mountains, as it used to be found quite commonly there.

Industry

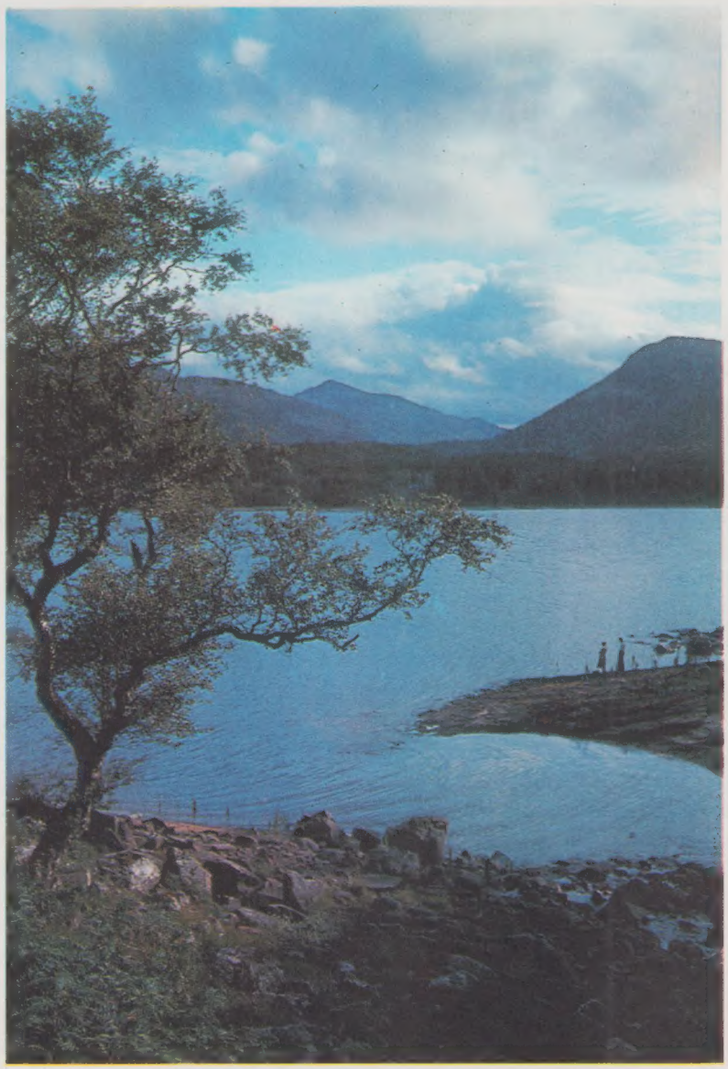
The Grampians do not provide an easy living. Much of the land is very poor and can be used only for grazing sheep, although in the east, where the climate and soil are better, cattle are reared and mixed farming is possible. Large tracts of land are kept as grouse moors and deer forests. The Forestry Commission is replanting some districts, and water from the lochs is being used to provide hydroelectricity.

The greatest 'industry' of the Grampians is the tourist industry. Although the weather is uncertain, many thousands of people flock to the district, staying at centres like Pitlochry and Aviemore. They come to climb the mountains, to shoot, and to fish for the trout and salmon which are plentiful in the rivers and lochs. Water ski-ing is rapidly becoming a popular sport on the larger lochs, and in winter, as we have seen, the mountain slopes draw many ski-ing enthusiasts.

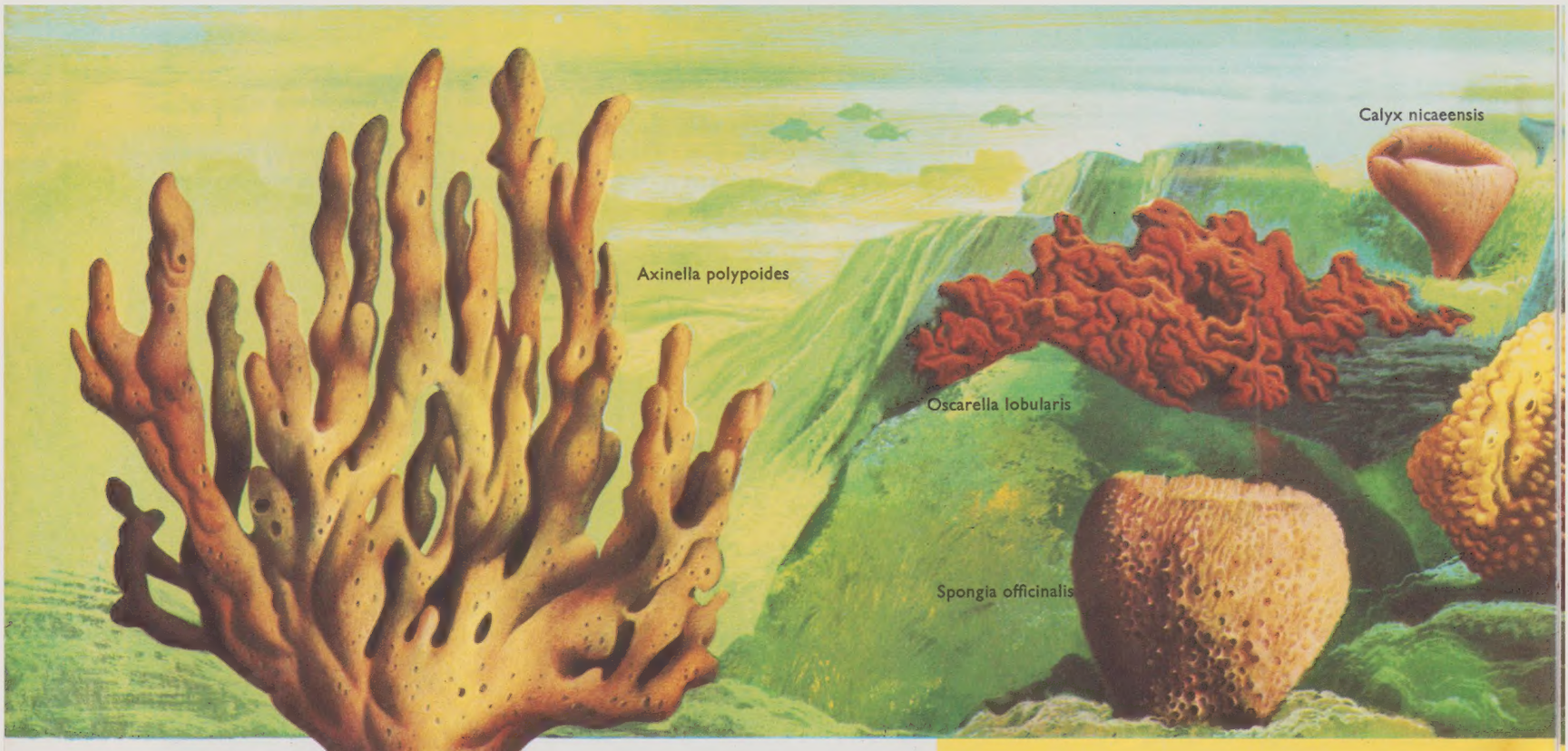
Naturalists also visit the Grampians, some to observe the wild animals, which include red deer, wild cats, red squirrels, golden eagles, ptarmigan, ospreys, and snow buntings, and others to see the rare alpine flowers for which Ben Lawers is famous.

But the greatest of all attractions for visitors is the truly magnificent scenery of the Grampians – scenery which inspired Lord Byron to write:

'England! thy beauties are tame and domestic
To one who has roved o'er the mountains afar:
Oh for the crags that are wild and majestic!
The steep frowning glories of dark Lochnagar!'



On the 'Road to the Isles' – Loch Rannoch, in the heart of the Grampians, lies encircled by mountains



SPONGES

ANIMAL, vegetable, or mineral? You must have played the game of finding out the identity of an object by asking 'yes or no' questions. Now if you were playing a game of this kind and the subject was a bathroom sponge, how would you answer the opening question? The sponge seems both dead and shapeless enough to be classed as a mineral. But if its origin as a living thing is admitted, is it plant or animal? Sponges were recognised as living creatures by the great Greek philosopher Aristotle in the 4th century B C, but he cautiously described them as something between a plant and an animal. The naturalists of the Renaissance were more inclined to regard them as plants, and it was not until the 19th century that zoologists made up their minds that sponges were animals.

Their classification is still a problem

In our article on the classification of the Animal Kingdom (see page 551) you will see that it is divided into two Sub-kingdoms, the **Protozoa** and the **Metazoa**. The Protozoa (animals like Amoeba) are unicellular (the individual consists of a single cell), and the Metazoa are multicellular or many-celled. The sponges are regarded as the most primitive group of the Metazoa and placed in a Phylum called the **Porifera**. Some zoologists, however, maintain that sponges are not really multicellular, but are highly organised colonies of unicellular animals. One solution to the problem is to create a whole new Sub-kingdom for the sponges, the **Parazoa**, and you will find this done in some books. However, as long as you remember that the sponges, or Porifera, are the most primitive of all the animals whose bodies consist of numerous cells, the actual method of classification is not of great importance.

WHAT IS A SPONGE?

Sponges are aquatic animals which are remarkable on account of the organs that they do *not* possess. A sponge has no limbs, eyes, stomach, or nervous system. All we can say is that the millions of cells that make up its body are of several different kinds, and have some sort of organisation; some are concerned with maintaining a flow of water through the sponge, others with digesting food, and others with building up its skeleton. This consists not of bones but either of a network of tough fibres or of thousands of little sharp *spicules* made of silica (flint) or calcium carbonate (chalk). Sponges are classified according to whether they have a fibrous, silicious, or calcareous skeleton.

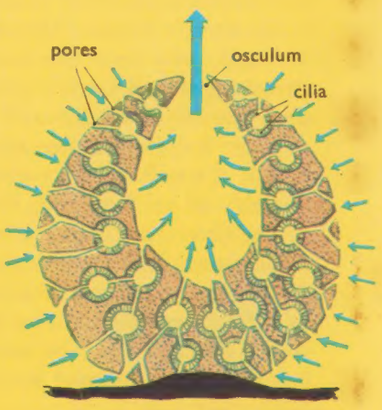


Diagram of the structure of a simple sponge; the arrows show the direction of the circulation of water

The body of a simple sponge is formed rather like a jar, with a small mouth and thick sides. It is covered with a thick skin, in which are thousands of tiny holes, or pores. (Porifera means pore-bearer.)

Water is sucked in through these pores and passed through the walls of the 'jar' into its interior. Each pore is the opening of a little canal, which leads to a round space called a *flagellated chamber*. This is lined with cells carrying tiny hairs or *cilia*, which lash continually in

This picture shows a selection of sponges. In the foreground are two common Mediterranean species, the bath sponge (Spongia officinalis) *and the yellow* Clionia *which usually lives on the shells of molluscs*

the water, driving it through the chamber and out by other canals which lead to the interior cavity of the sponge. In this way a continual circulation of water is maintained: in by the pores, through the flagellated chambers, into the internal space, and out by the mouth or *osculum*. The two diagrams, one life-size, the other magnified, illustrate this. The size of the pores is exaggerated; they are really invisible to the naked eye.

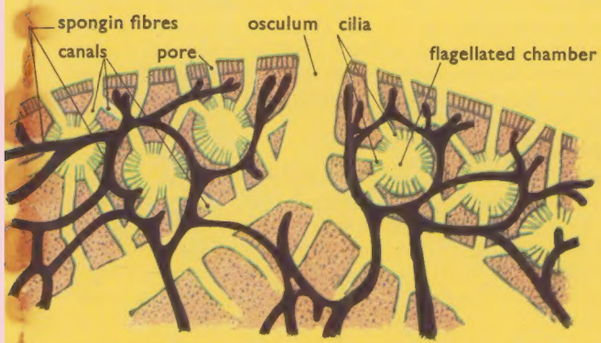


Diagram of a section through part of a sponge with a fibrous skeleton

COMPOUND SPONGES

If you try to apply the description we have given of a simple sponge to the one in your bathroom you will be rather puzzled, because a bath sponge is full of holes of various sizes. These are all out-flow mouths or oscula; the bath sponge is best regarded as consisting of many 'jars', all crowded together and more or less connected with each other. In fact the bath sponge is a compound, not a simple, sponge. Another point to remember is that the sponge we use consists only of the skeleton of the animal, which in this group of sponges is formed of a fibrous material called *spongin*. When the sponge was taken from the sea all the part into which water soaks when you use it was filled with the jelly-like living matter of the animal, and it was covered with a continuous skin, perforated only by the minute pores. All this living matter is allowed to decompose and is washed away when the sponge is prepared for the market.

Of the 20,000 species of sponges that are known, only six are of commercial value. They are found mainly in the Mediterranean and the region of the Gulf of Mexico, from Florida to the West Indies. They are collected partly by divers, partly by working with a long-handled harpoon from a boat, and partly by dredging.

THEY FEED ON BACTERIA

A fair-sized sponge passes about a gallon of water through its pores every minute. The sponge uses this stream of water as a means of respiration, and also as a source of food.

Partly because the pores are extremely small, and partly because digestion takes place inside the individual cells of the sponge, the food must consist of very minute particles, and sponges are thought to subsist largely on bacteria.

REPRODUCTION

Sponges reproduce by producing enlarged cells or 'eggs', which are fertilised and developed into embryos inside the parent body, and are then passed out through the osculum. They hatch into minute larvae, which swim by means of cilia and eventually settle down to grow into new sponges. A piece cut or broken off a sponge will also grow, like a cutting from a plant. In fact pieces of live sponge have been crushed and sieved in water through a fine silk mesh. The cells separated by this process will come together and form new sponges. This is one reason for regarding sponges as unicellular animals.

A BEAUTIFUL SPONGE

Most sponges are shapeless, dull-coloured masses of tissue, whether one considers the living animal or the skeleton; but some of the silicious or flinty-skeleton kinds are exceptions to this rule. The skeleton of the Venus's flower basket (*Euplectella aspergillum*), a sponge which lives in deep water in the Pacific Ocean, is a most beautiful object.

Skeleton of a Venus's flower basket

WHERE THEY LIVE

Sponges are found in all seas and at depths down to 3,000 fathoms, but they are most abundant in the warm, shallow seas of the tropics. A few occur in fresh water, and five species of these are found in Britain, two of them commonly. The flinty spicules of sponges are found as fossils in rocks of all ages, from those of the Cambrian period, 600 million years ago onwards.

D-DAY

Assault troops wade ashore on to Omaha beach – scene of heavy allied losses on 'the longest day'

The illustrations for this article are based on the 20th Century-Fox film, *The Longest Day*

TO the war-weary inhabitants of Britain the spring of 1944 brought an excitement which was almost refreshing. It was obvious that something tremendous was afoot. Troops were flocking into Britain from all parts of the Empire and Commonwealth, from the United States, from France, and even from Poland. Columns of soldiers marched through the streets on their way to the many camps springing up all over the country. In every port, harbour, and bay, big or small, along the south coast, ships began to congregate. Amphibious craft rushed through the water and sped along the English beaches. They were watched by wide-eyed little children – children who gazed in wonder at the anchored warships, and who ran after American GIs with their inexhaustible supplies of chewing gum.

The children had no idea of what was going on. Nor, for the most part, had the troops. But in General Eisenhower's headquarters plans were being perfected for the most ambitious military operation in the history of warfare – the invasion of Europe, code-named operation 'Overlord'. The date of the invasion was called 'D-Day'.

The Normandy beaches

After a detailed study of the entire enemy coastline from Denmark to Brittany the Normandy beaches were selected for the invasion. These beaches, five in all, stretched for 50 miles from the region of Caen to the Cotentin peninsula. They were a less obvious invasion point than the Pas de Calais, and were within range of supporting aircraft bases in England.

The beaches were code-named from east to west: 'Sword', 'Juno', 'Gold', 'Omaha', and 'Utah'. The plan was to land assault forces on the beaches, secure the beach-heads, and capture certain localised positions. Meanwhile the forces would be built up with further invasion shipments of men and equipment, until they were ready to break out of Normandy and strike towards Germany.

Three main factors decided the invasion date. The tide was all-important, for it had to be low enough for the advance troops to clear a path through the mines and obstacles cluttering the beaches. Secondly, there had to be enough daylight at the right time for a concentrated supporting bombardment from aircraft and warships. Thirdly, there had to be a moon, for parachute landings were to take place behind enemy lines in the hours of darkness preceding the seaborne landings. The provisional date, in May 1944, had to be abandoned because of the shortage of landing craft, and of the other possible dates – the 5th, 6th, and 7th June – the 5th was chosen.

By June there were in Britain no fewer than 17 British divisions, 20 American, one French, and one Polish. There were 5,407 fighter aircraft, 3,467 heavy bombers, and 7,250 other aircraft, including 2,591 gliders. More than 6,000 ships were waiting along the coast. Equipment included bridges, ramps, amphibious tanks, and ancient ships to be sunk to form breakwaters ('Gooseberries'). There were two astonishing large and hollow concrete harbours ('Mulberries') to be towed across the Channel, and a cross-Channel pipeline ('Pluto') to feed petrol from tankers on to the Normandy shore. In all, there were 2,876,439 allied officers and men waiting for the gigantic armada to set out. These colossal preparations were supported by equally remarkable 'side-shows' to mislead the enemy. A dummy head-

quarters with dummy tanks was established in Dover, and dummy ships crowded into south-eastern ports as if the landings were to be in the Pas de Calais region. For every air mission over Normandy, two flew over the Pas de Calais. The initial assault forces were to be: the 6th British and 82nd and 101st American Airborne Divisions; the 1st US Army, consisting of the 7th Corps (4 divisions) and the 5th Corps (3 divisions); and the 2nd British Army, comprising the 30th Corps (4 divisions) and the 1st Corps (3 divisions). Of the five beaches, Utah was allotted to the US 7th Corps, Omaha to the 5th Corps, and Gold, Juno, and Sword to the British 30th and 1st Corps.

General Montgomery was to command all land forces until General Eisenhower was able to transfer his headquarters to France.

German preparations

German Intelligence was aware of the massive build-up in the United Kingdom. Hitler boasted of the 'Atlantic Wall', describing it as 'a belt of strong points and gigantic fortifications from Norway to the Pyrenees', but it was, in fact, far weaker and less complete than the German people were led to believe. The *Luftwaffe* had been virtually knocked out of the sky, and continuous and intensive bombing was wrecking German communications and armament production. Hitler himself was degenerating both physically and mentally, and a group of high-ranking officers were plotting his assassination. Nevertheless, Germany was not finished. The allies were alarmed by mysterious, unidentifiable erections on the French coast. They turned out to be launching sites for Hitler's secret weapons, the V1s and V2s. Heavy bombing prevented launchings before 13th June, but before the end of the war these weapons had caused no fewer than 31,600 casualties in Britain alone. Had D-Day been postponed, or the landings seriously checked, Hitler might yet have dislocated allied plans and made London uninhabitable.

To meet the threat of invasion the Germans had about 60 divisions in western Europe under Field-Marshal von Rundstedt. Suspecting that the invasion would come in the Pas de Calais region, the Germans kept their powerful 15th Army (17 divisions) there, where it proved useless when invasion came. The 7th Army (15 divisions), under General Dollmann, himself under Field-Marshal Rommel, was in Normandy. Rundstedt and Rommel disagreed over tactics. Rundstedt wanted to let the allies land and repulse them with a well-organised counter-attack. Rommel wanted to destroy them on the beaches.

Rommel's view, being Hitler's also, prevailed. It meant that, once the Atlantic Wall had been broken, the German command could never summon enough reserves to drive the allies back.

The invasion of Europe

By June 1944 everything was ready. During the last feverish months supplies had been pouring in at 1,900,000 tons per month. Since April 66,000 tons of bombs had been dropped in Normandy, with the object of isolating the battle-area and preventing the Germans moving up reinforcements rapidly. Individual attacks were made on radar stations, airfields, and coastline defences. On the eve of D-Day 10 radar-equipped batteries in Normandy were destroyed and the rest were jammed.

On 1st June the troops were at last given their long-awaited orders, and the complicated business of loading was begun. Heavy seas caused D-Day to be postponed until 6th June. Then, at 1.30 a m on 6th June parachutists of the 6th British Airborne Division were dropped near Breville, and the 82nd and 101st American Divisions were dropped beyond Utah beach. Shortly after midnight RAF bombers had begun dropping 6,000 tons of bombs on military targets between Cherbourg and Le Havre. At dawn US heavy bombers dropped over 3,000 tons on the shore defences in the half hour before the landings began. Then fighters swarmed in to attack individual targets.

At 6.30 a m the first troops landed under heavy supporting fire from the naval convoys, which stopped directly the invaders were on the beaches. The tanks were landed first, providing further fire cover as assault troops were landed and engineers began to blast gaps in the formidable beach defences.

The invasion came as a shock to the Germans. Rommel was visiting his wife, and Dollmann and other leading commanders were also absent. Shortly after the sea-borne landings began Rundstedt asked for permission from the German Army Headquarters to bring up the Panzer reserves. Permission was not given until about 3.30 in the afternoon, when it was too late to bring them into action that day. This was because Hitler was asleep at the time and no one dared wake him.

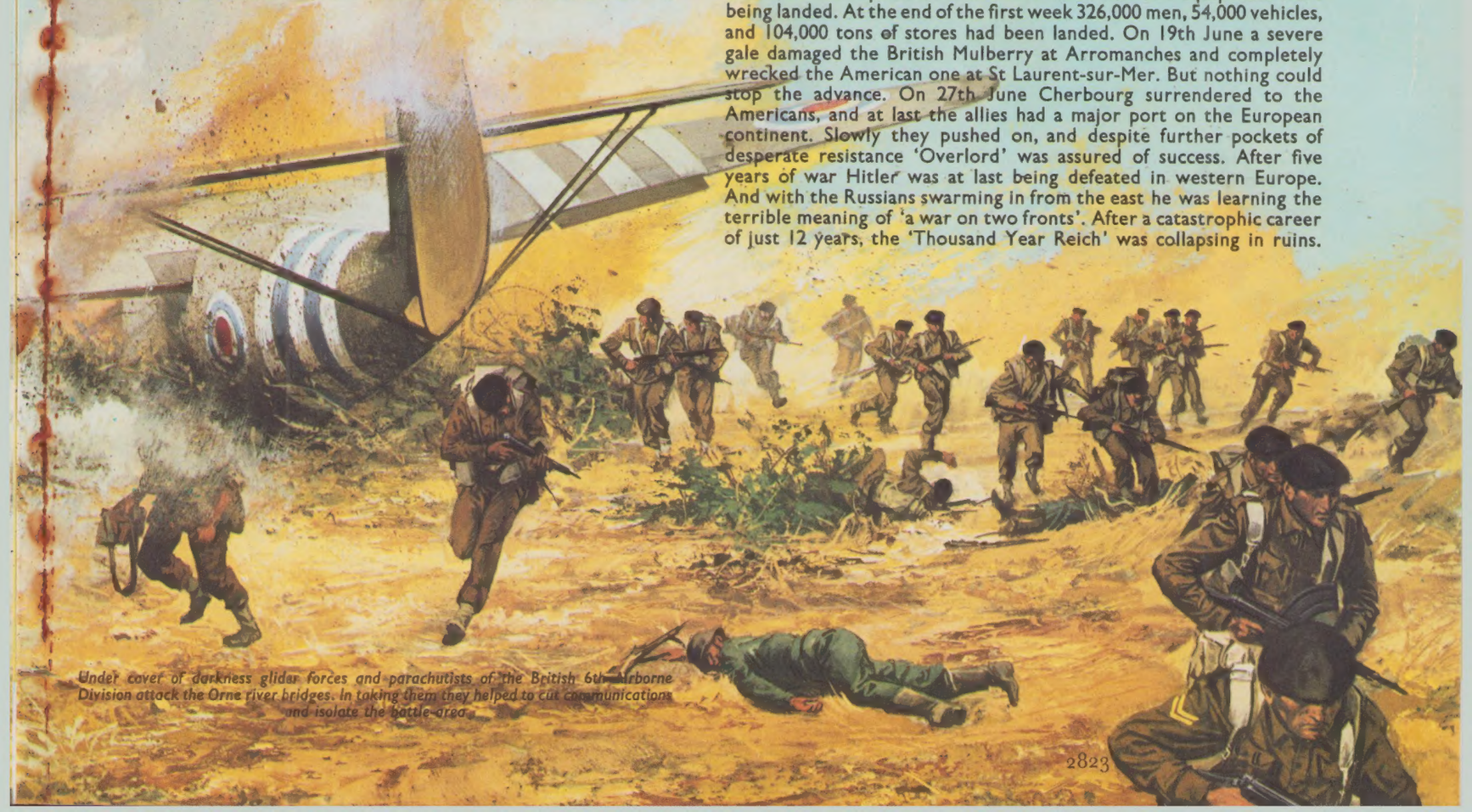
It was during the afternoon of the 6th that Rommel returned, and for once he, Rundstedt, and Hitler agreed. Thinking that the Normandy landings were a decoy to cover further landings in the Pas de Calais, they left the 15th Army well away from the battle-area.

Meanwhile the landings on all five beaches were succeeding to varying degrees. On Utah beach the Americans penetrated over six miles and made contact with the 101st Airborne Division. On Omaha beach there were heavy casualties as rough seas caused most of the amphibious tanks to be lost. The Americans were pinned down on the shore lines by the 352nd German Division until late in the day, when they managed to reach the coast road. The 2nd British Army met with stiff resistance on Gold beach, but its left wing advanced rapidly inland. The Canadians on Juno beach pushed forward to a depth of seven miles, and on Sword beach, Bieville and most of Ouistreham had been captured by late afternoon.

The allies storm up Sword beach in a determined attack on heavily-fortified Ouistreham

The only major counter-attack was delivered against the British in the afternoon by the 21st Panzer Division. It penetrated to the coast, but was beaten back. Meanwhile the allies enjoyed complete dominance in the air. Out of 14,600 sorties flown over hostile territory on D-Day, not one plane was shot down. By nightfall the allies had broken through the Atlantic Wall between the rivers Vire and Orne on a front of 30 miles.

The days after D-Day were anxious ones. Counter-attacks were delivered and repulsed. All the time more men and equipment were being landed. At the end of the first week 326,000 men, 54,000 vehicles, and 104,000 tons of stores had been landed. On 19th June a severe gale damaged the British Mulberry at Arromanches and completely wrecked the American one at St Laurent-sur-Mer. But nothing could stop the advance. On 27th June Cherbourg surrendered to the Americans, and at last the allies had a major port on the European continent. Slowly they pushed on, and despite further pockets of desperate resistance 'Overlord' was assured of success. After five years of war Hitler was at last being defeated in western Europe. And with the Russians swarming in from the east he was learning the terrible meaning of 'a war on two fronts'. After a catastrophic career of just 12 years, the 'Thousand Year Reich' was collapsing in ruins.



Under cover of darkness glider forces and parachutists of the British 6th Airborne Division attack the Orne river bridges. In taking them they helped to cut communications and isolate the battle-area

EUROPE: economy

EUROPE is the most densely populated continent in the world. One-fifth of the world's population lives there, yet it includes only one-twentieth of the total land surface. It stretches from the British Isles in the west to the Russian Urals and Caspian Sea in the east, and from Finland in the north to the Iberian and Italian peninsulas in the south. Nature has been generous to much of this great region. Almost every country has easy access to the sea, which has stimulated overseas trade. Fertile soil and adequate rainfall allow abundant crops and pastureland in most countries, while climatic variations range from the Arctic tundra belt to sub-tropical Georgia.

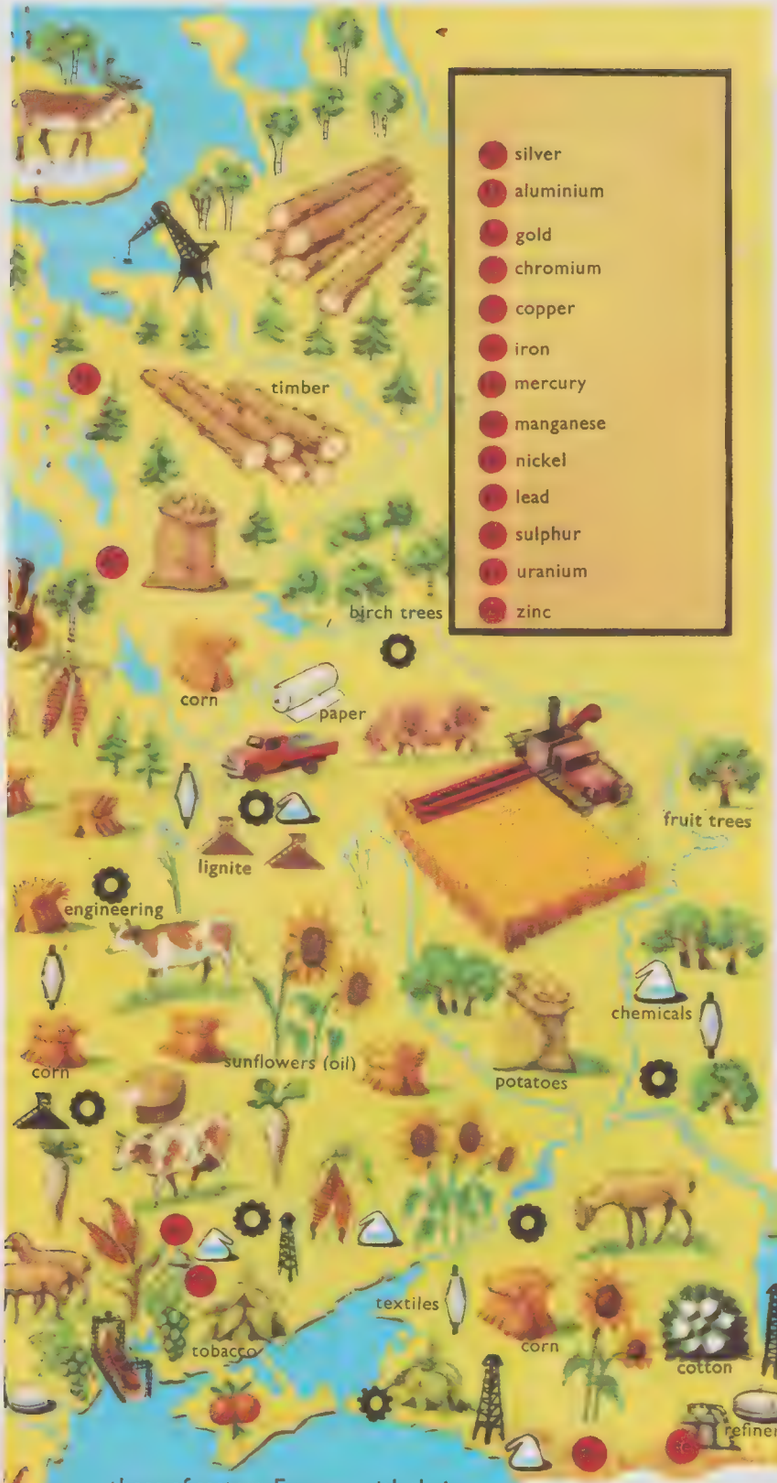
The widespread existence of coal and iron ore, and a vigorous and ingenious people, ensured that Europe would lead the world in industrial development. And, indeed, it was Britain who powered the Industrial Revolution two centuries ago (see page 621).

Agriculture

Europe produces more wheat, oats, rye, and barley than any other continent; it also has more cattle and sheep, and a greater output of dairy produce.

Some countries are mainly agricultural, especially

Map showing the wide diversity of Europe's agricultural and industrial products



those of eastern Europe, with their fertile plains and wide grazing lands. European Russia has a vast output of wheat, rye, and livestock. Denmark, Belgium, and Holland have important dairying industries, while the Mediterranean lands, with their hot, dry summers, produce a great variety of fruits, including olives, oranges, lemons, peaches, apricots, and almonds.

The forests of Scandinavia, northern Russia, and Austria form the basis of rich timber and paper industries, while fishing is a major industry in Scandinavia, the Low Countries, and the British Isles.

Mining

Europe has great mineral deposits, and possesses about one-half of the world's mineral wealth. Coal, the most important product, is abundant in northern France, Belgium, southern Holland, the Ruhr, Saxony, Silesia, the Donets Basin, and Britain. Iron ore is another important mineral, the chief areas of production being the north of Spain, Lorraine in eastern France, Sweden, and southern Russia.

All kinds of minerals are produced – oil in Russia; zinc in south Poland; lead and mercury in Spain; platinum, copper, and manganese in Russia; and many others throughout the continent, including bauxite, tin, chromium, magnesium, sulphur, uranium, gold, and silver.

Industry

Founded on steam power and the growth of railways, the industries of European nations produce more manufactured goods and employ a greater proportion of the total population than those of any other continent. The greatest industrial centres are Great Britain, Russia, Germany, France, Belgium, and Italy. But industrial development is taking place in almost every country, much of it based on great advances in hydroelectric power.

Metal goods, textiles, chemicals, pottery, glass, and refined oil are all major European industrial products. In particular, the British automobile industry, Germany's electrical and chemical industries, and Russia's steel output have all developed to a massive size. Switzerland's precision instruments – especially watches – have a universal reputation.

Food-processing industries – flour-milling, meat-packing, and sugar-refining – are also widespread.

Tourism

Tourism is a major factor in the economies of many European countries. The great European cities of London, Paris, Vienna, and Rome, and the beautiful scenery of Austria and Switzerland, the bulb-fields of Holland, historic Venice, and many other magnificent features of Europe draw many thousands of visitors from all parts of the world.

Trade and communications

Trade is vital to many countries of Europe, and the long coastlines, great navigable rivers like the Rhine, Danube, and Volga, and the thick network of railways ensure an increasing volume of traffic. Railways are especially highly developed in western Europe, and Russia, too, has an extensive network. Natural obstacles such as the Alps and Pyrenees have been overcome by building passes and tunnels.

FLYING

A modern cabin aircraft, suitable both for pleasure flying and for the business executive who has to visit factories in different parts of the country

IT is said that when a large, modern jet aircraft comes in to land the loudest sound on the intercom which connects the crew on the flight-deck is the heavy breathing of the pilot. It is the most difficult moment of the flight. The pilot may be tired after many hours in the air. He may have in his hands the responsibility for 100 or more lives, and also for a machine worth over £2 million. Furthermore, the weather conditions may be very far from ideal for a landing. Rain, mist, or low cloud may impair the pilot's view. It may be only when he is within 1,000 feet or so of the runway that he will see the spot where his aircraft must touch the ground.

Fortunately, not all flying is as arduous as that of the airline captain. Each summer week-end in Britain thousands of quite ordinary people fly for the sheer pleasure which they obtain from a brief jaunt through the sky. Of course, their responsibility is trivial compared with that of the airline pilot. They fly small aeroplanes in good weather, and there are seldom more than two passengers. So long as they have a licence, obey the rules of the air, and bring their machines back to the hangars undamaged, they have nothing to fear.

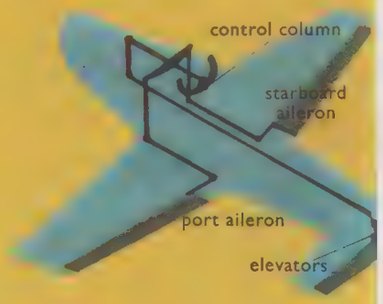
It sounds exciting, it is exciting, and in this article we will describe how it is done.

IN CONTROL

Imagine that you are sitting in the pilot's seat of a modern sporting aircraft. The controls are all arranged conveniently in front of you, and just beyond them on the dashboard there is a mass of dials and gauges.

Immediately in front of you is the *control column*. It is shaped like an inverted pair of handle-bars. If you grasp it firmly you will find that it both rotates and moves backwards and forwards. This double movement is necessary because the one control is used to operate two quite independent *control surfaces* – the *elevators* and the *ailerons*.

Backward and forward movement of the control column operates the elevators, the hinged sections attached to the trailing edges of the tail-plane. When the column is pushed forward the elevators bend downwards below the general surface of the tail-plane,



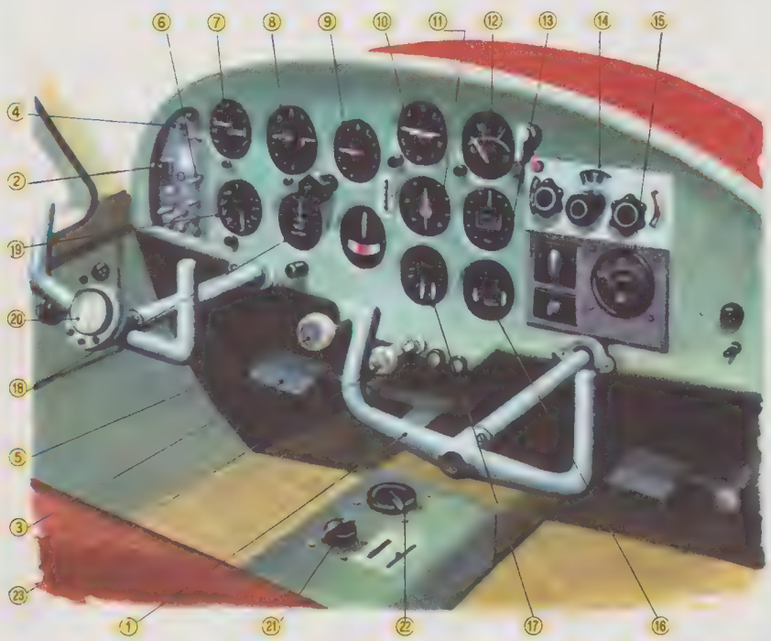
The control column regulates the position of the ailerons and elevators

and the altered course of the airflow over the tail causes it to rise. The aeroplane thus goes into a dive.

Pulling back on the control column causes the elevators to bend upwards above the general surface of the tail-plane. The tail drops and the aircraft begins to climb.

Rotation of the control column operates the ailerons, the control surfaces attached to the trailing edges of the wings. Unlike the elevators, which always work in conjunction, the ailerons always work in opposition. When the control column is rotated clockwise the left aileron bends downwards and the right aileron bends upwards. The effect is to alter the airflow over the wings and so cause the aircraft to tilt to the right. Rotation of the

THE CONTROLS AND INSTRUMENTS OF A MODERN CABIN AIRCRAFT



1 ram's horn control column
2 controls for retractable undercarriage
3 rudder bar
4 starter button
5 throttle
6 switch for navigation lights
7 air speed indicator
8 artificial horizon
9 rate of climb indicator
10 engine tachometer (revolution counter)
11 magnetic compass
12 fuel gauge
13 engine coolant temperature gauge
14 radio receiver and transmitter
15 direction-finding apparatus
16 external temperature gauge
17 oil pressure gauge
18 gyro-compass
19 altimeter
20 clock
21 fuel supply valve
22 contact
23 propeller pitch control

AN AEROPLANE

The rudder bar regulates the position of the rudder

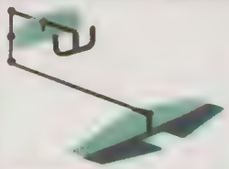
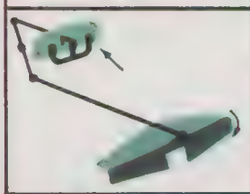
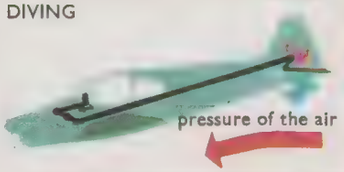
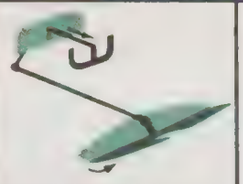
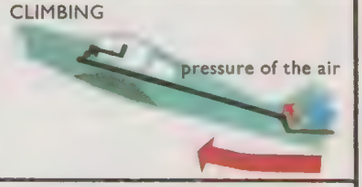
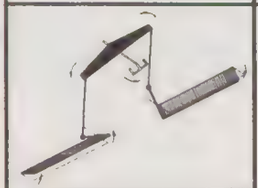
control column in an anti-clockwise direction causes the aircraft to tilt to the left. This tilting movement is called *banking*, and it is very important when an aircraft is turning. In modern high-performance aircraft the ailerons are often used both to bank and to turn the aircraft.

The second control is the rudder bar at your feet. As its name implies, it operates the rudder attached to the trailing edge of the fin. When the right foot presses on the bar the rudder bends to the right of the fin, and the aircraft turns to the right. When the left foot presses on the bar the aircraft turns to the left.

In practice the rudder is never used alone when the aircraft is in the air, as this would result in a great deal of *sideslipping* and a very large turning circle. The aircraft is first banked with the ailerons to avoid the sideslip and then the appropriate amount of rudder is applied. Modern fast aircraft use the rudder chiefly to correct 'yaw', or slewing round of the tail, during turns brought about by use of the ailerons.

There are many other controls, besides the control column and the rudder bar, with which you must be familiar before you can fly. There is the control to operate the wing *flaps* used to increase lift at take-off and landing, and a small wheel to adjust the *trim* of the aircraft so that it flies quite level. There is the *starter* for the engine, and the *throttle lever* which controls engine speed. There is a pedal to operate the wheel brakes, and if the undercarriage is retractable, a button to move it up and down.

On the dashboard there is a range of instruments which tell you how fast, how high, and in what direction you are flying. In addition there are more complex instruments for use at night and when the aircraft is flying through cloud. Besides these there are several gauges which report the performance of the engine. They tell the number of revolutions per minute, the oil pressure, the engine temperature, and the amount of fuel available.

Position of control column	Pilot's action	The effect on the aircraft
	The control column is central. The rudder bar is level. The throttle is adjusted to 'cruise'	STRAIGHT AND LEVEL
	The control column is pushed forwards. The elevators bend downwards and the aircraft begins to dive	DIVING 
	The control column is pulled backwards. The elevators bend upwards and the aircraft begins to climb	CLIMBING 
	The control column is rotated anticlockwise. The aircraft banks and turns to the left	TURNING TO THE LEFT
	The control column is rotated clockwise. The aircraft banks and turns to the right	TURNING TO THE RIGHT

TAXI-ING

Now the time has come for a flight. First you must inspect your aircraft to make sure that all is in order. See that there is fuel in the tank, oil and engine coolant, and that the control surfaces are free. Then set the altimeter and the clock.

Once sufficient speed is attained the aircraft can begin to climb

Next you can start the engine. Make sure that the aircraft is in a place where the dust blown up by the slipstream will not damage other aircraft, set the control which regulates the pitch of the propeller to 'fine', make sure that the brakes are on, adjust the throttle, and press the starter. The engine bursts into life.

While the engine warms up, the cockpit check is carried out. The controls are tested, the switches tried, and the safety belts fixed. Then it is time to taxi to the end of the runway. Take off the brakes, and run up the engine in short bursts to move your aircraft forward. You will find that it is quite easy to control by means of the rudder and the brakes.

TAKE-OFF

When you reach the end of the runway look carefully to see that all is clear; then taxi gently on to the concrete and turn the nose of your aircraft into the wind. Apply the brakes and test the engine at full power for a few moments by opening the throttle to 'full'. If all is well, throttle down and wait for the control tower to give permission to take off.

Open the throttle to full, off brakes, and away you roll. Faster and faster down the runway you go, maintaining a straight course with the rudder. Flying speed is soon reached. Pull backwards gently on the control column, and your aircraft lifts from the ground.

Fly level for a few seconds to gain speed, close the throttle a little to normal climbing power, and pull back on the column again so that the aircraft begins to climb. You can now retract the undercarriage and the flaps, and change the pitch of the propeller to 'coarse'. When the desired height is reached you must ease the column forwards a little so that the aircraft begins to fly level, and as you do this adjust the throttle so that the engine gives the correct power for cruising flight. If all is now well, and your aircraft is properly 'trimmed', it will fly very nearly by itself.

TURNING

All too soon it is time to alter course for home. To turn your aircraft you first increase the engine speed a little to compensate for the extra drag caused by the use of the control surfaces. Next the bank is put on, by rotating the control column a little to the left. The left wing drops, and now it is possible to apply left rudder without sideslipping. Press your left foot on the rudder bar and your aircraft begins to move round in a gentle sweep.

Once the aircraft is heading in the correct direction the rudder is moved back to the central position by a little pressure with the right foot. The control column is rotated back to remove the bank, and the throttle is adjusted again to 'cruise' power.

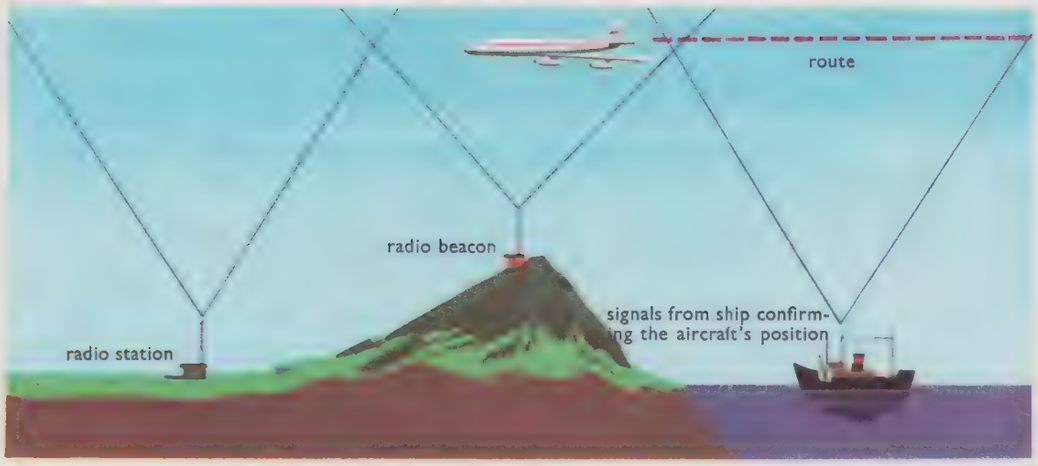
LANDING

Soon your airfield is in sight. You must now push the control column forwards a little, to put your aircraft into a shallow glide towards the runway. You can reduce engine power, and it is now time to change the pitch of the propeller back to 'fine', to lower the undercarriage, and extend the flaps.

The attitude of an aircraft on landing

When you reach the airfield, fly along the runway once at about 1,000 feet to make sure that all is clear and that you can see any other aircraft that are about to land or take off. Turn left (this is the general rule) in a large circle, until you are again at the downwind end of the runway. It is now time to come in.

On this approach the throttle is closed almost completely and your aircraft glides to the end of the runway. Once over the threshold you must ease backwards very gently on the control column so that the aircraft flattens out, loses some speed, and drops gently to the concrete. Taxi quickly to the end of the runway, for there may be others coming in behind you.

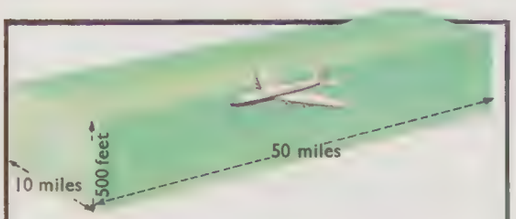


The pilot uses radio signals from many different sources to inform him of his position and to keep him on the correct heading

Flying on instruments

Flying for pleasure is usually done in small aeroplanes, and in good weather when the pilot can easily see where he is going. He can also see that his aircraft is in the correct 'attitude', or that it is flying in the correct position relative to the ground. Military and commercial aircraft cannot wait for a fair day for their flights and often they have to fly in the dark, in clouds, or in heavy rain, all of which make the land and the horizon invisible. Under these conditions a pilot quickly loses his sense of direction, and even of 'up' and 'down', and if he were not provided with instruments to tell him these things a disaster would be inevitable.

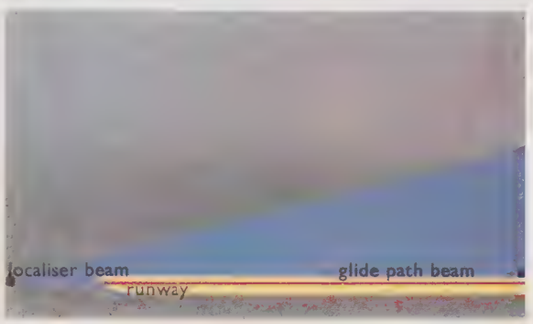
The *artificial horizon* tells the *attitude* of the aircraft – that is, whether it is climbing, flying level, or diving, and whether or not the aircraft is tilted to one side. The *altimeter* tells the *absolute height* above sea level, and the *rate of climb indicator* shows whether this is increasing, remaining steady, or decreasing. The *airspeed indicator* shows the speed of the aircraft through the air. The *gyro-compass* indicates the *heading*, or direction in which the aircraft is flying; if the aircraft is flying in a circle the *rate of turn indicator* shows how fast the heading is changing. Other instruments such as *engine revolution counters*, *sideslip indicators*, and so on, give additional useful, though less essential, information.



The 'box in space' in which an aircraft flies

A 'FLYING BOX'

With the increasing density of air traffic, collisions in the air become a greater danger. One way in which this kind of accident can be avoided is to ensure that all aircraft are separated by reasonable distances. In official airways it is arranged that no aircraft shall follow another at the same height at a distance of less than 50 miles, or fly on a parallel course nearer than 10 miles. Vertically the aircraft are separated by 500 feet. Each aircraft thus has around it a moving 'box' of air 50 miles long, 10 miles wide, and 500 feet deep.



A diagram of the ILS radio beams

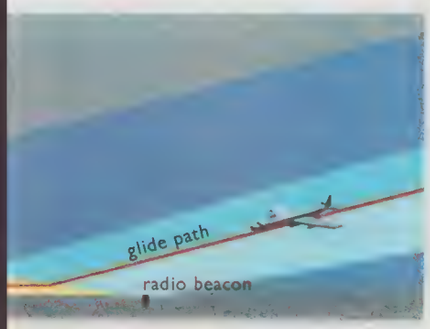
Air traffic control

Small sporting aircraft flying below 2,000 feet need little overall control. Their pilots can see where they are going and can easily alter course if a collision seems imminent. But for large commercial aircraft, flying at high speeds and congregating in large numbers in the vicinity of airports, the situation is very different. Very close control of each individual aircraft is absolutely necessary if collisions are to be avoided. There are three different controllers.

The **Area Controller** regulates aircraft as they fly from one airport to another. His main method is to channel the aircraft into airways, in such a way that those flying in one direction do not meet head-on with those flying in the opposite direction. He watches his charges on his radar screens and warns the pilot of danger when other aircraft come too close to him.

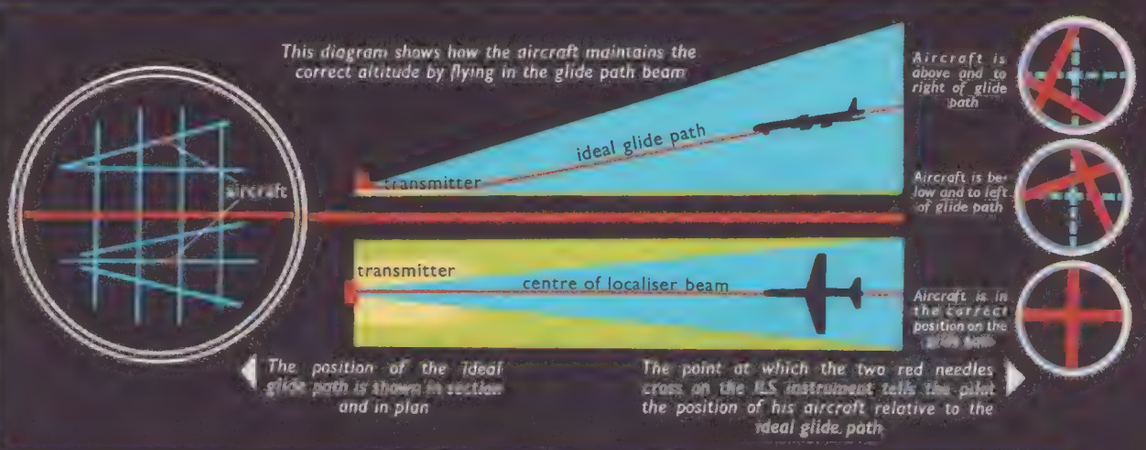
The **Approach Controller** regulates the aircraft both as they come in to land and as they fly out. It is his task to bring incoming aircraft to the runway in an orderly fashion. When several aircraft approach the airport at the same time he instructs them to circle in a 'stack' some distance from the end of the runway and then calls each in to land separately.

The **Airport Controller** regulates the aircraft as they move about on the runways and taxiways. He is also responsible for the movements of the many vehicles which are used to service the aircraft.



GROUND CONTROLLED APPROACH AND THE INSTRUMENT LANDING SYSTEM

When the visibility at an airport is low, and the pilot of an incoming aircraft is unable to see the runway where he must land his aeroplane, he can be given a great deal of help by the Approach Controller. The Controller sees the aeroplane on two special radar screens, and he can tell the pilot exactly how to fly until he is near enough to see the threshold of the runway. This *Ground Controlled Approach* (GCA) has the great advantage of requiring no equipment on the aircraft other than a radio.


This diagram shows how the aircraft maintains the correct altitude by flying in the glide path beam
ideal glide path
transmitter
aircraft
transmitter
centre of localiser beam
Aircraft is above and to right of glide path
Aircraft is below and to left of glide path
Aircraft is in the correct position on the glide path
The position of the ideal glide path is shown in section and in plan
The point at which the two red needles cross on the ILS instrument tells the pilot the position of his aircraft relative to the ideal glide path

A much more elaborate method of bringing aircraft safely within sight of the runway threshold is that known as the *Instrument Landing System* (ILS). In this system each aircraft is brought by the Approach Controller to a spot in line with the runway and about 5 miles distant from the threshold. Here the aircraft flies into two fan-shaped radio beams which are sent out by transmitters at the airport. One beam, the *localiser beam*, is transmitted in a vertical plane. If the aeroplane veers to one or other side of this beam, the strength of the radio signal diminishes; this is registered on a dial, showing the pilot that he must correct his heading. The other beam, the *glide path beam*, is transmitted upwards from the runway at an angle of $2\frac{1}{2}$ degrees. Deviations above or below this beam are registered by a second needle, often on the same dial, and this warns the pilot that he is either too high or too low. Additional help is given to the pilot by three radio beacons arranged along the course of the glide path. Their purpose is to tell him how far he has to go before the threshold is reached.

As the pilot of this Boeing 707 comes in to land at night he has not only the assistance of ILS but also visual aid from the Calvert system of approach lights and the lights at the ends of, and along the edges of, the runway

CITIES OF MEXICO

The brilliance and

IN 1519 Hernan Cortes, a Spaniard, became the first European to set foot on what is now Mexican soil. With his small company of soldiers he made the arduous climb to the central plateau, and there, near its southern margin, he saw one of the strangest and most magnificent cities in the world – Tenochtitlán, the capital of the Aztec Empire (see page 442). Its great temples and palaces, however, can have made little impression on Cortes, for in 1521 he returned and destroyed Tenochtitlán, establishing in its place the foundations of the present-day capital of Mexico, Mexico City.

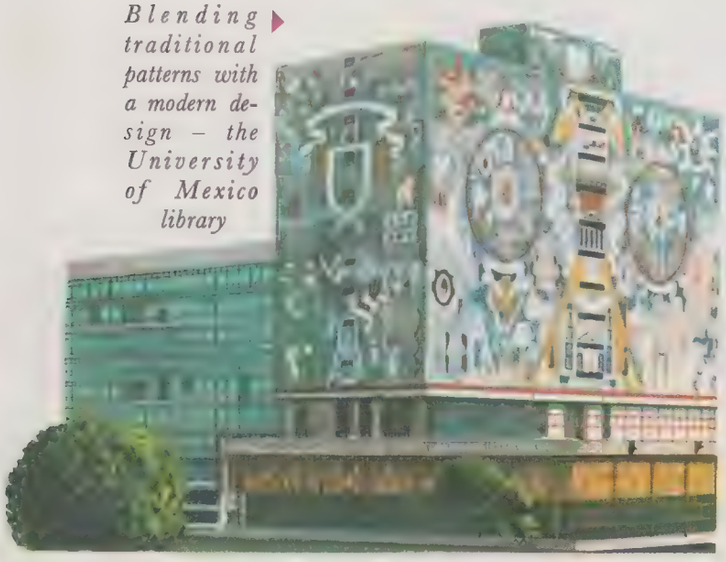
This city retains little of the Aztec capital, except the design of its principal thoroughfares. Like Tenochtitlán, the centre of Mexico City is built round a great square – the Zócalo – from which the main streets of the city radiate like spokes. The Spanish conquerors made this square the political and commercial centre of the city, and grouped a number of stately buildings round it, including a great cathedral. They also laid out the wide tree-lined *paseos* (avenues) for which Mexico City is famous.

The principal cities of Mexico

A great modern capital

If you were to visit Mexico City you would probably be impressed first by its strikingly modern buildings and bustling life. The Federal District, of which the Spanish colonial city forms the nucleus, has grown enormously in this century. With a population of over 5 million, Mexico City is now the third largest city of the Western Hemisphere. Great American-style skyscrapers dominate its skyline; it has many modern department stores, factories, and housing estates; and sumptuous modern buildings have been added, such as the new university. You can see its library in the picture below.

This rapid development has been largely due to the growth of industry. Until the 20th century Mexico City served mainly as a market town for the fertile agricultural region surrounding it; its lack of power prevented the early development of manufacturing industries. However, with hydroelectricity and oil, and the growth of modern communications, Mexico City has become the country's chief industrial centre, and now contains one-third of all its factories. Mexico City provides a number of incentives for industrial development. As the centre of the country's communications network, it is ideally situated to receive raw materials, and to market manufactured goods. It is surrounded by flat land suitable for building, and can provide a plentiful supply of labour (see page 2264).



Blending traditional patterns with a modern design – the University of Mexico library

But this industrial prosperity has also had its unfortunate consequences. Small farming villages have been engulfed by the advancing tide of factories and housing estates, and thousands of peasants have migrated to the city to seek work. Many of them have failed to find a proper home, and so a belt of shanty slums, with inadequate sanitation and water, has grown up around the capital. It has been estimated that as many as 1½ million people in Mexico City live in these terribly unhealthy conditions.

The modern port of Vera Cruz, which handles most of Mexico's foreign trade

Vera Cruz

Vera Cruz (137,413), on the Gulf of Mexico, is the most important Mexican port, and handles most of the country's foreign trade. It was founded in 1609 by the Spaniards, and used by their fleet bringing supplies to the empire in the New World. But Vera Cruz lacks a good natural harbour, and breakwaters have had to be built to prevent silting. However, the extensive areas of flat land surrounding the port have enabled modern docks to be constructed.

Vera Cruz has recently lost some of its trade to Tampico, another Gulf port, since the opening up of the coastal oilfields and the expansion of industry in northern Mexico.

glitter of Mexico City at night. The floodlit cupola shines out in memory of those who fought in the revolution of 1910

Monterrey

Monterrey (596,939) was founded in 1596 in a break in the north-eastern Sierra Madre range of mountains. It is now the second most important industrial city of Mexico, and the main city of the north. It has developed rapidly in this century as a result of the growth of communications within the country, and its position on the Inter-American Highway has laid it open to influence from the United States.

Monterrey produces about a million tons of iron and steel a year – 75 per cent of Mexico's total output. It is also the country's main producer of lead and manufactures cigarettes, furniture, tiles, glass, and beer.

GUADALAJARA

Guadalajara (734,346) was one of the first towns to be built by the Spaniards in Mexico. It is an important market town for the fertile agricultural region in the west of Mexico, and also has considerable manufacturing industries, including tiles, clothing, soap, and glassware.

It is an important road and railway junction on the route between central Mexico and the north Pacific coast, and for centuries has been Mexico's second city. But it may lose this distinction to Monterrey, which is now expanding much faster.

PUEBLA AND MÉRIDA

Puebla (285,284), founded in 1531, is only 78 miles from Mexico City. It lies among high volcanic mountains, and has long been an important agricultural and administrative centre. It is Mexico's principal cotton manufacturing city and also produces tiles and palm-leaf hats.

Mérida (177,405) is the most important town of the Yucatán peninsula. It lies in the north-west of the peninsula, and the flat land around the city is devoted almost entirely to growing *henequen*, used in the sisal industry, of which Mérida is Mexico's main centre.

DID YOU KNOW?

1. Mexico City (7,500 feet) is one of the world's highest capital cities.
2. On Lakes Chalco and Xochimilco in Mexico City there are still a few of the floating gardens (*chinampas*) for which the ancient city of Tenochtitlán was famous.

The beautiful bay and luxury hotels of Acapulco, Mexico's famous holiday resort, which attracts thousands of tourists every year

Acapulco

On the Pacific coast, isolated from the rest of Mexico by the high mountains of the Sierra Madre del Sur, lies the beautiful holiday resort of Acapulco. During the Spanish colonial era Acapulco was the chief port for trade with the Orient. Ships bearing spices, silks, and slaves for the *Conquistadores* anchored in its harbour. When the Spaniards left it reverted to the status of a minor fishing village. But now that it has been connected to Mexico City by a new main road, Acapulco has come to life again. Every year thousands of American holiday-makers pour in to enjoy its beaches and atmosphere.

BONIFACE VIII

The seal of Pope Boniface VIII

THE old Pope was at Anagni, his native town. The next day, 8th September, was to be an important day, for it was to see the publication of a papal bull denouncing Philip IV of France and absolving his subjects from their allegiance to him.

Suddenly the peace was shattered as Philip's agent, Guillaume Nogaret, stormed into the town at the head of 1,600 troops. Fighting their way to the papal residence, they seized the terrified old man with the intention of carrying him off. Eventually the citizens rallied to their Pope, and Nogaret withdrew. But the once proud spirit of Pope Boniface VIII was broken. The following month he died; and with him died an era. For never again would a Pope attempt to fulfil his claim to be sovereign of sovereigns, and to rule them as his vassals.

The state of the Papacy

In the late 13th century the old order in mediaeval Europe was breaking down. Powerful rulers of powerful states refused to regard the Pope as their overlord. They were more interested in fighting each other than in uniting under the Papacy for a crusade. They resented paying papal taxes. They wanted to appoint their own candidates to vacant bishoprics. Instead of standing aloof from national quarrels, the Papacy eagerly joined in. The Popes became more and more involved in secular politics. They supported one nation against another and made diplomatic alliances. They enlarged the papal states. Some Popes favoured their own families and acquired large estates for them. In 1282 the Papacy plunged into the long, fruitless war of the 'Sicilian Vespers', supporting the unsuccessful Angevin candidates for the throne. A bitter quarrel broke out within the Sacred College of Cardinals between the mighty families of Orsini and Colonna, who had differing policies over Sicily.

Statue of Boniface VIII – an out-of-date but very able Pope

An ambitious Pope

At last, in July 1294, the cardinals temporarily tired of politics. They elected as Pope a celebrated hermit, Celestine V, whose short pontificate was little more than a fiasco. He never visited Rome, and after a few months was persuaded to abdicate by Cardinal Benedetto Gaetani. This ambitious man, who had won a great reputation as a lawyer, was elected as Boniface VIII.

Few Popes have had more exalted aspirations than Boniface. Had he lived a century earlier he might have been one of the very great Popes. But his ideas were out of date, though few realised this at the time.

Boniface at once purchased huge areas of the Campagna for his family, which infuriated the Colonnas. The two Colonna cardinals questioned the validity of Celestine's abdication and Boniface's election, and were placed under the papal ban. A costly war brought Boniface victory over the Colonnas. In 1298 their stronghold of Palestrina was destroyed. They fled into exile and continued to hurl defiance at Boniface from a safe distance.

The Colonna cardinals had been further provoked by Boniface's policy towards Sicily. They favoured conciliation, but Boniface was determined to win it back for the Papacy. He failed. After a war of varying fortunes Boniface's candidate, Charles of Valois, was routed, and the Peace of Caltabellotta (31st August 1302) ended the long war. It was ratified by an angry Boniface the following year.

The fatal quarrel

Boniface's ambitions went far beyond territorial aggrandisement for his family and the conquest of Sicily. In 1296 he published the famous bull, *Clericis Laicos*, which stated that no taxation on the clergy should be levied without papal consent. This brought the Papacy into conflict with the most powerful sovereigns of the day. In England a violent quarrel broke out between Edward I and the Archbishop of Canterbury, Robert Winchelsea, who tried to uphold the bull. Papal relations with England were strained, but the situation in France was far graver. Philip deprived the Pope of Church revenue and sheltered the Colonna exiles. Boniface summoned the French king to Rome to answer before a papal council. In 1302 he issued a bull, *Unam Sanctam* – perhaps the most outspoken statement of papal claims ever made. It laid down that the Pope was not only the supreme spiritual head but also the temporal head of the entire Christian community. Philip's answer was to convene a national assembly at Paris, which charged the Pope with heresy and proposed that he be tried before a General Council. Without waiting further, the French attempted to carry off the Pope, who died on 11th October 1303.

How does Boniface rank among Popes? Among mediaeval Popes he is, no doubt, inferior to the two 'Greats', Gregory and Leo, and to Gregory VII and Innocent III as well. But, after them, he was possibly the most able. His administrative genius left a permanent mark on ecclesiastical government. In 1298 he published the *Sext* – a collection of the decretals issued since Gregory IX, which was largely made up of his own judgments. In 1300 he inaugurated the brilliantly successful Jubilee Year, and in the same year he drew up his *Super Cathedra*, which settled the vexed question of the exact position of the Mendicant Friars.

Boniface was, perhaps, a great Pope, without ever being a good one. He lacked the holiness and humility appropriate to a divine office, but he had qualities of a ruler not entirely out of place in days when the Papacy was still a temporal power.

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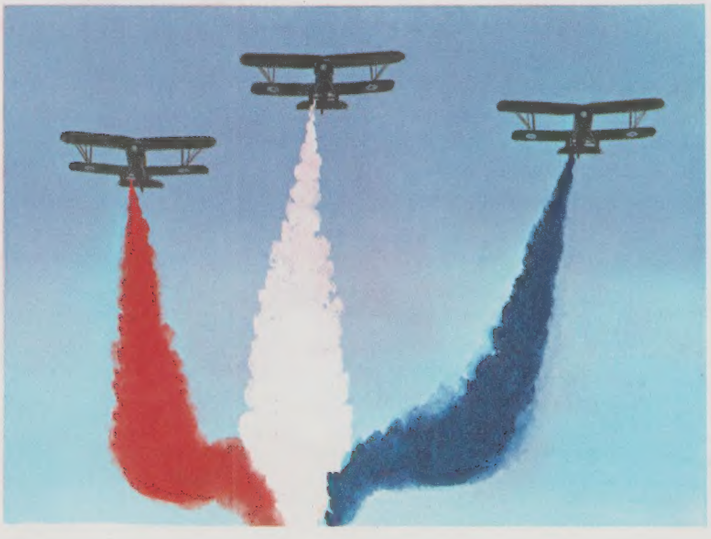
The First World War

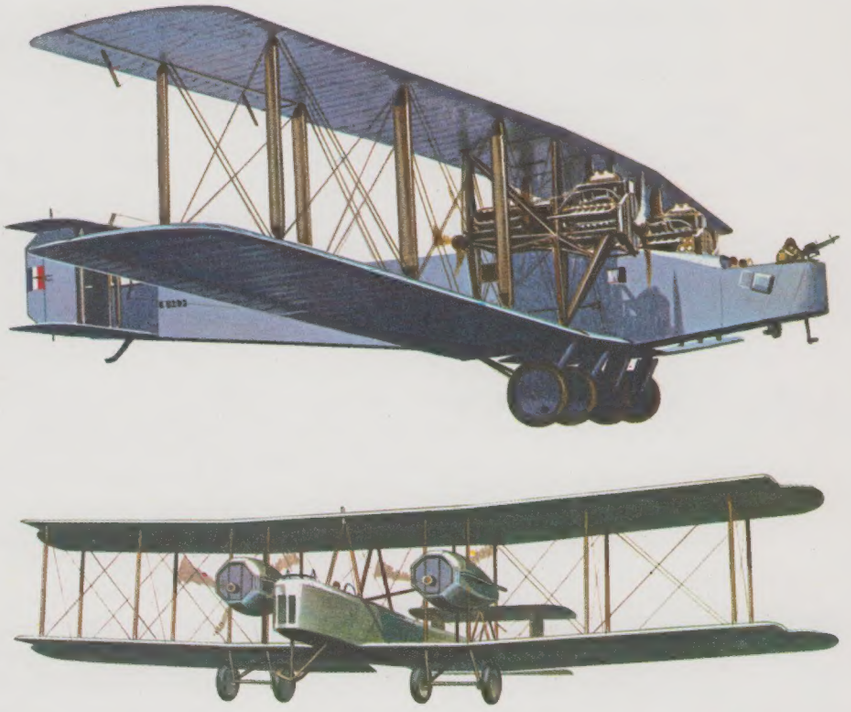
The new Corps was regarded by the War Office mainly as a reconnaissance arm, and the detachment of 73 aircraft which went to war in France in August 1914 was not armed except for the pistols, rifles, and hand grenades with which some crews experimented unofficially. The first armed aircraft had Lewis machine-guns and were delivered to the RFC in September 1914, but they remained few in number, and the first air-combat victory was scored with a rifle by a pilot of 4 Squadron, who shot down a German Albatross over Dunkirk on 22nd January 1915. Bombing was tried with 25-pound and 100-pound bombs two months later. It was done at low level, aiming by guesswork, and it took great courage. It won the first aerial VC, posthumously, for 2nd Lt. W. B. Rhodes-Moorhouse, in an attack on Courtrai station on 26th April 1915.

Air warfare truly began in July 1915, and the German airmen, being far less restricted by conservative Army command, won the first round. They introduced a Fokker monoplane with a synchronising gear to fire machine-guns forward through the propeller. The RFC reconnaissance machines and primitive bombers – by this time proving surprisingly useful to the Army – were swept out of the sky. They fought back by going up each with at least three armed 'scout' planes. Soon it was learned that the scouts had to fly in combat formations to survive and to challenge the enemy effectively. 'Dog-fights' began between individual planes, and with them the first major battle for air supremacy which swung back and forth between the Allies and the Germans – but more often in favour of the Germans – until the last six months of the war. It was the Germans who introduced strategic bombing in 1915 by sending first their Zeppelins and later their Gotha bombers over England.

In 1917 the RFC and RNAS began at last to plan with full official and public support to strike back. Heavy bombers were ordered, and four first-class fighter types – the Bristol F.2B and DH4, the Sopwith Camel and SE5 – came into service. The Gotha raids stopped, and British raids on Germany began; 5,500 tons of bombs were dropped between January and November 1918.

Gloster Grebes at the 1930 *Hendon Air Display*





Two bombers which appeared at the end of the First World War: the Vickers Vimy (1917 – *bottom*) *and the Handley Page V*/1500, *built in* 1918 *and intended for bombing Berlin*

Formation of the RAF

On 1st April 1918, following an historic report by the great South African General Jan Smuts, the Royal Air Force was formed. It was the first independent air service of any major power. Great strides in aviation had been made during the war, and by the time it ended eight months later in November 1918 the flimsy, all-purpose aeroplanes of 1914 had given place to machines that were specially designed for the job they were to do. There were different kinds of aeroplanes for air-combat, for bombing, and for reconnaissance and photography. Speeds had increased from 70 to 150 miles an hour, and engine power from 70 to 400 horsepower. The Royal Air Force now had 22,647 aircraft and 188 squadrons. There were 401 home stations and 274 stations abroad. Among the RAF's new aircraft was the multi-engined Handley Page V/1500, which could carry 30 230-pound bombs to Berlin.

Lord Trenchard, who took command of the RFC in 1914 as a Lieutenant-Colonel, rose to the rank of General in four years of war, and came home as the first Chief of Air Staff. He ran the peacetime force down to a mere 12 squadrons in 1919 so that he could start his visionary, long-term plan for building the RAF from scratch. He worked closely with Mr Winston Churchill,

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who, as Secretary of State for War and Air, introduced the plan to Parliament in December 1919. It was agreed, but the budget awarded for the next five years was only £15 million a year; the general opinion was that there would never be another war and so there would be no need for a large air force.

After the war

The secret of Trenchard's ultimate success was that he used his little money to build a strong, supple backbone for the RAF, to which limbs could be added surely when the hour came. He established a college at Cranwell to train young officers, and another at Halton to train technical apprentices. An RAF Staff College was opened to study the tactics of air warfare and to train new generations of Air Staff. The slender resources of RAF aircraft were spread abroad wherever there might be small, localised ('brushfire') wars, to prove in action that the air arm was the most effective and economical.

New rank titles for the RAF

A separate Air Ministry was set up to control the Royal Air Force, and new rank titles – mostly different from both those of the Royal Navy and the Army – were introduced. For officers, the ranks were: Marshal of the Royal Air Force, Air Chief Marshal, Air Marshal, Air Vice-Marshal, Air Commodore, Group Captain, Wing Commander, Squadron Leader, Flight Lieutenant, Flying Officer, and Pilot Officer. For non-commissioned ranks, the titles were: Sergeant-Major, Flight Sergeant, Sergeant, Corporal, Leading Aircraftman, Aircraftman 1st Class, and Aircraftman 2nd Class. Subsequently the title of Sergeant-Major was replaced by that of Warrant Officer, and a new rank of Senior Aircraftman was introduced between those of Corporal and Leading Aircraftman.

RAF Aircraft Strengths

August 1914 (RFC)	239 (less than 100 operational)
November 1918	22,647
December 1933	850
September 1939	1,911
May 1945	55,469
April 1956 (post-war peak)	2,000

RAF Budgets

1920	£15,000,000
1930	£20,000,000
1939	£245,000,000
1950	£223,000,000
1956 (post-war peak)	£618,000,000
1964	£504,000,000

RAF records between the wars

Airmen were encouraged to make long-distance flights linking the countries of the Commonwealth and to strive for speed and altitude records, all of which not only improved the breed of aircraft but captured the imagination and support of the British people. The Schneider Trophy was won outright by Flt. Lt. J. N. Boothman (later Air Marshal) of the RAF High Speed Flight on 13th September 1931, with the Supermarine S.6B – forerunner of the Spitfire – and 16 days later the same plane set the world speed record at 407·5 m p h.

The RAF's annual Hendon air displays became not only the most exciting spectacle in the country but also the magnet which attracted the young men and boys who later won the Battle of Britain.

The RAF expands

RAF expansion began in 1934, and in 1936 the four great Commands – Bomber, Fighter, Coastal, and Training – were set up. Air Marshal Sir Hugh Dowding was appointed to Fighter Command, and began the build-up of the revolutionary technical and tactical organisation – the high-speed fighters, radar, VHF radio, and centralised operational control from the ground – which enabled him, five years later, to lead the Battle of Britain pilots – the 'Few' – to beat back the invading Luftwaffe.

The great strength of the RAF, which springs from its struggling early history and leadership, is its basic organisation geared to the special needs of air warfare. It was this which enabled it to expand so rapidly and fight so effectively when the challenge came in 1940.

RAF Firepower – examples

Biggest bomb 1914	25 lb
Biggest bomb 1918	1,650 lb
Biggest (conventional) bomb 1945	22,000 lb
Atom bomb 1956	22,000 *TONS* of TNT equivalent
Hydrogen bomb 1957	1,000,000 *TONS* of TNT equivalent

Bomber Offensives

January–November 1918	5,500 tons
14th–15th October 1944 (largest raid – 1,576 aircraft)	5,453 tons
1939–1942	121,298 tons
1943	157,500 tons
1944	525,000 tons
Total September 1939–May 1945	955,040 tons*

*Less than one 1 megaton H-bomb.

Lord Trenchard, the first Chief of Air Staff